

LOW TEMPERATURE EVALUATION OF THE UNITRODE UC3846 CURRENT-MODE PWM CONTROLLER

Test Report

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Results and Discussion

Testing of the device was initially performed at 20 °C after which measurements were taken at lower temperatures. At each test temperature, the device was allowed to soak for 15 minutes before measurements were made. Performance of the device as a function of temperature is depicted in Table I. Listed are the source current (I_s), minimum and maximum duty cycle (D), internal reference voltage (V_{ref}), and the switching frequency at the different test temperatures. The lowest test temperature at which data is reported in Table I is – 110 °C. That is because the device ceases to operate beyond this temperature. The effects of the extreme low temperature exposure on the device, however, are not permanent as it fully recovers when the temperature is brought back to about – 110 °C or higher. This is evident from the same parametric values exhibited by the device at the two room temperature readings taken before and after the thermal cycling. Throughout these tests, an input of 12 V was supplied to the device and a control voltage between 2 and 4 V was used to vary the duty cycle.

It can be seen from Table I that while the maximum duty cycle does not change with temperature, its minimum counterpart tends to gradually increase as the temperature is decreased. At –110 °C, for example, the minimum duty cycle attained was 39.5 % compared to 10.9 % at room temperature. The internal reference voltage exhibits gradual but very slight decrease as temperature is decreased. While the frequency does not undergo any appreciable change with temperature, the supply current exhibits a decrease only at temperature of –75 °C and lower. As was mentioned before, these temperature-induced changes in the device characteristics, between +20 °C and -110 °C, tend to be transitory as all investigated parameters regain their original values after the temperature stress has been removed, as indicated in Table I.

Table I. UC3846 device characteristics at various temperatures.

Temperature (°C)	I_s (mA)	D_{min} (%)	D_{max} (%)	V_{ref} (V)	Freq (KHz)
20	17.9	10.9	48.2	5.06	29.8
0	18.6	11.0	48.6	5.02	29.7
-25	18.7	13.4	48.7	5.01	29.9
-50	18.5	14.0	48.8	4.99	30.2
-75	18.3	12.4	48.8	4.94	30.2
-100	17.4	14.2	48.9	4.91	30.3
-105	16.2	24.0	48.9	4.91	30.3
-110	14.5	39.5	48.9	4.90	30.3
-115		--	--		--
20	18.2	11.0	48.3	5.05	29.8

Waveforms of the device reference voltage, oscillator, and the two modulated output voltages, which were recorded with the duty cycle at its maximum, are shown in Figure 2 at test temperature of 25 °C. These waveforms were also recorded at the lowest test temperature of –110 °C under the same conditions and are depicted in Figure 3. It is quite evident that the device undergoes very little changes in its operational behavior as a result of this limited low temperature exposure between 25 °C and -110 °C.

Conclusion

The Texas Instruments/Unitrode UC3846 current-mode PWM controller, which is a commercial-grade device rated for 0 to 70 °C operation, has been evaluated for potential use in low temperature applications. The device was characterized in terms of its switching frequency, internal reference voltage, and duty cycle control as a function of temperature. The results of this preliminary work indicate that the device is limited in terms of operation in cryogenic applications. Under short-time exposure to low temperature, the device displayed good operational behavior with temperature down only to –110 °C. Beyond that temperature, the device loses its functionality but recovers when higher temperatures are introduced. Nonetheless, the low temperature limit of –110 °C by far exceeds the manufacturer's temperature specification of the device.

References

1. Texas Instruments, Inc. Analog and Mixed-Signal Data Book, 2000.

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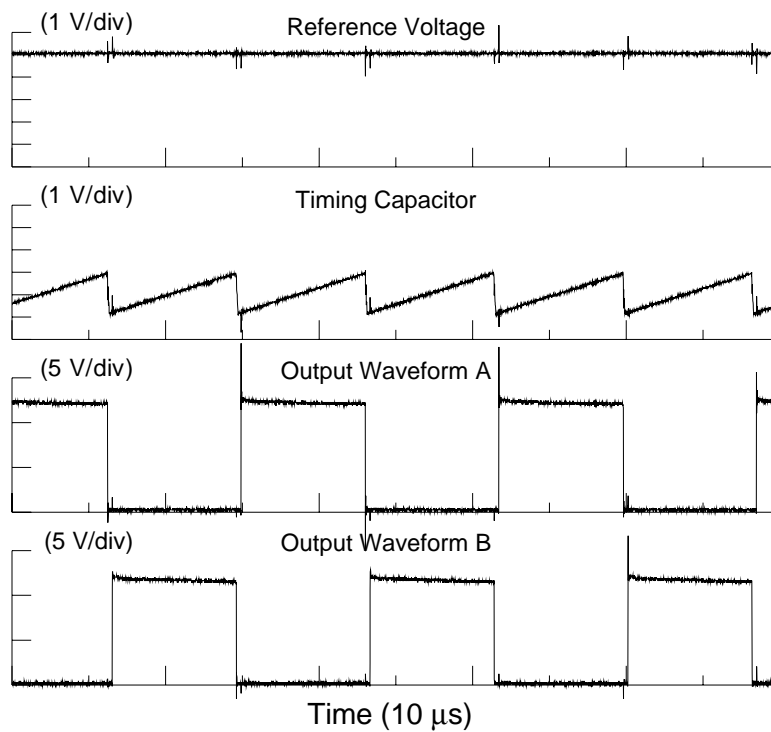


Figure 2. Waveforms of the UC3846 controller at 20 °C.

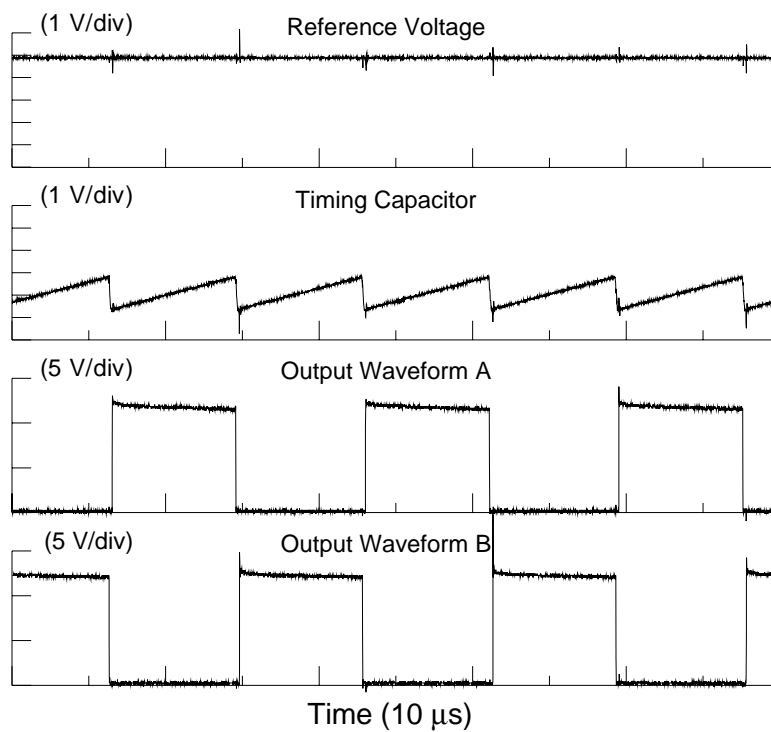


Figure 3. Waveforms of the UC3846 controller at -110 °C.